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(54) **LASER DIODE DRIVING DEVICE AND OPTICAL SCANNING DEVICE**

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(52) **U.S. Cl.** ..... **372/38.02; 372/38.1**

(58) **Field of Classification Search** ..... **372/38.02, 372/38.1**

See application file for complete search history.

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(57) **ABSTRACT**

A laser diode driving device capable of obtaining a stable pulse emission state even when variation in the current-light amount characteristic of a laser diode thereof is caused by environmental changes. A photodiode detects the amount of light emitted from the laser diode. A laser controller determines the amount of light to be emitted from the laser diode. Further, the laser controller controls the laser diode to emit light in the determined light amount. A bias current value-determining section determines a bias current value based on results of light emission performed by the laser diode in three or more kinds of light amounts determined by the laser controller.

**10 Claims, 7 Drawing Sheets**

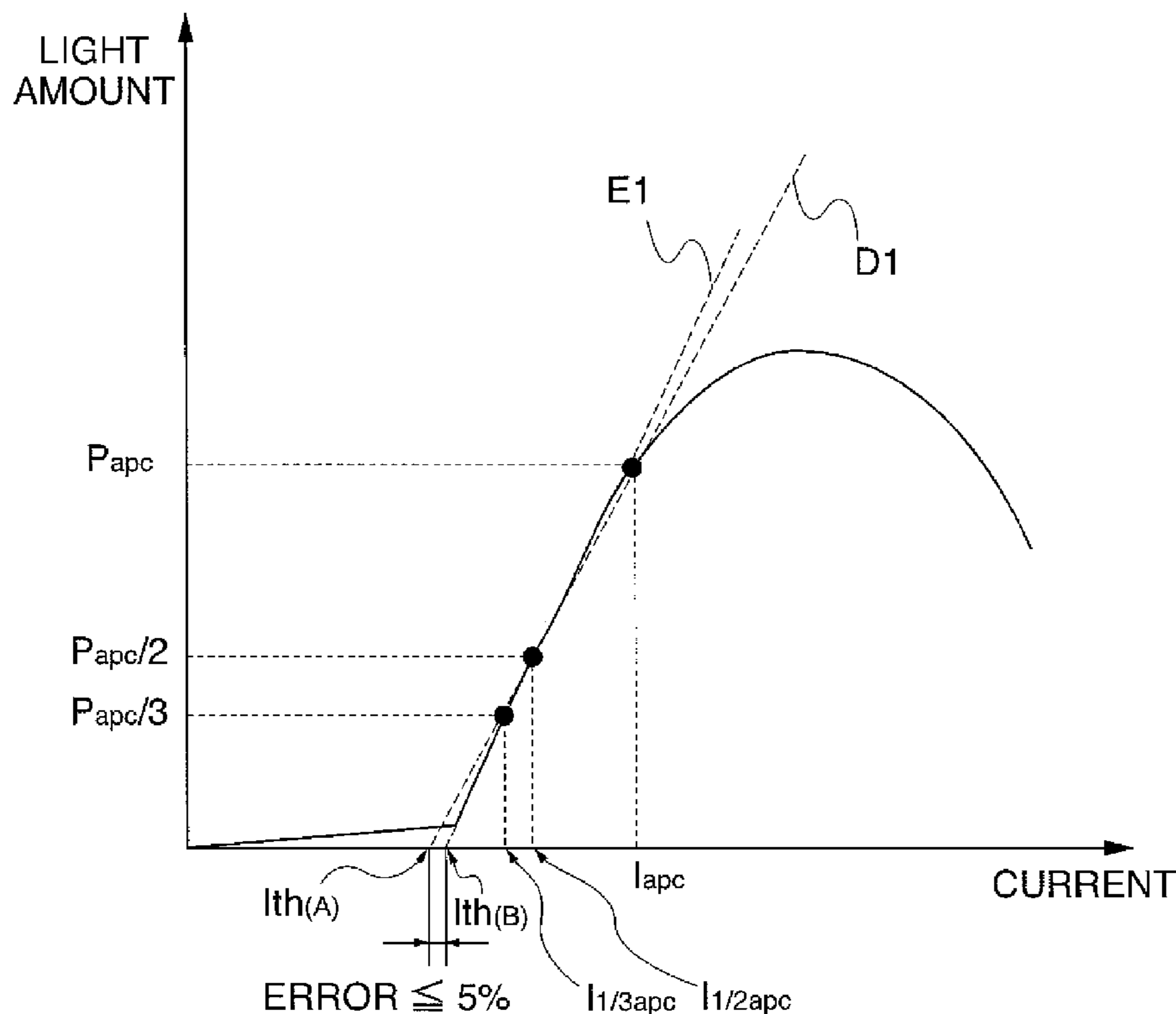
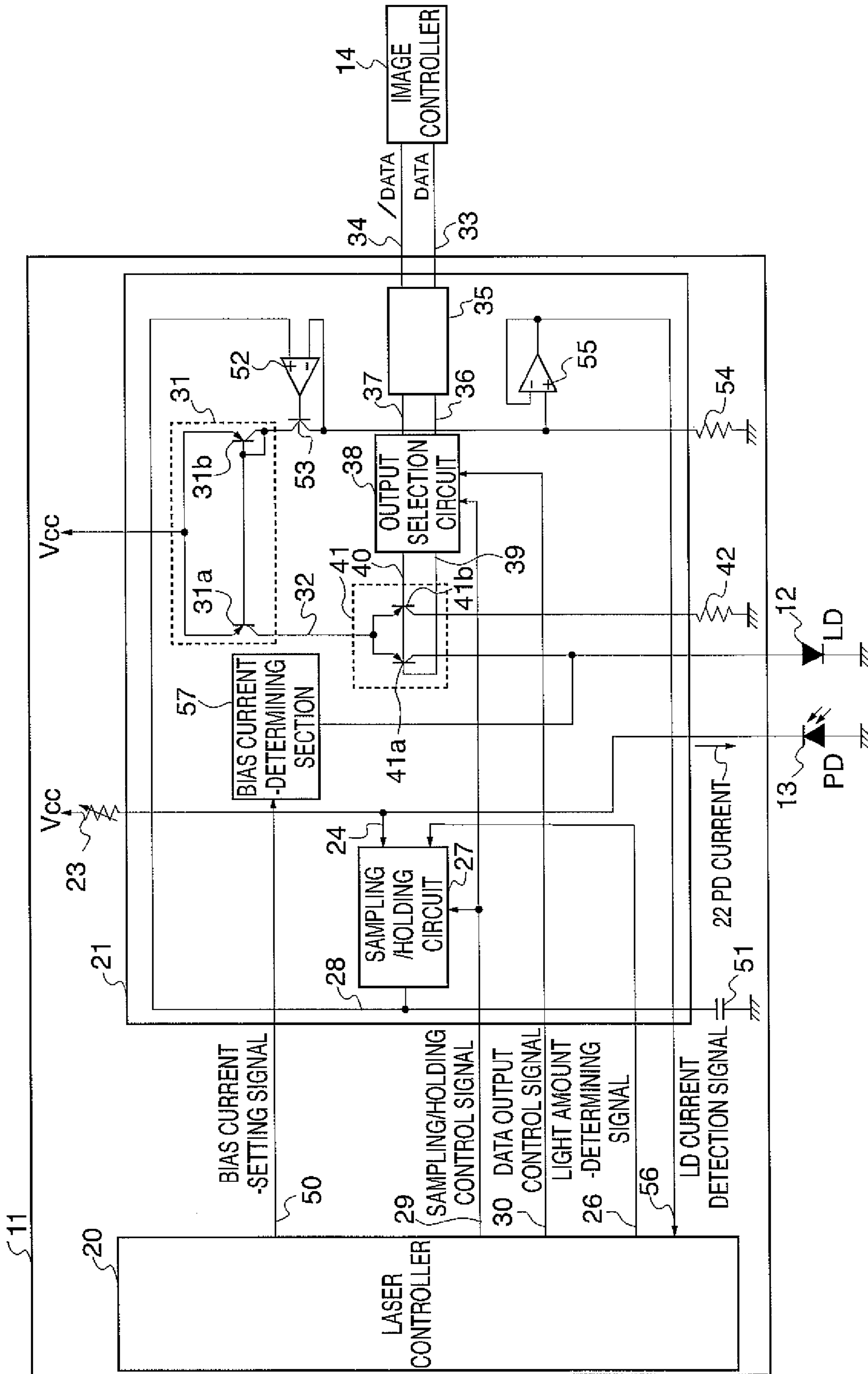
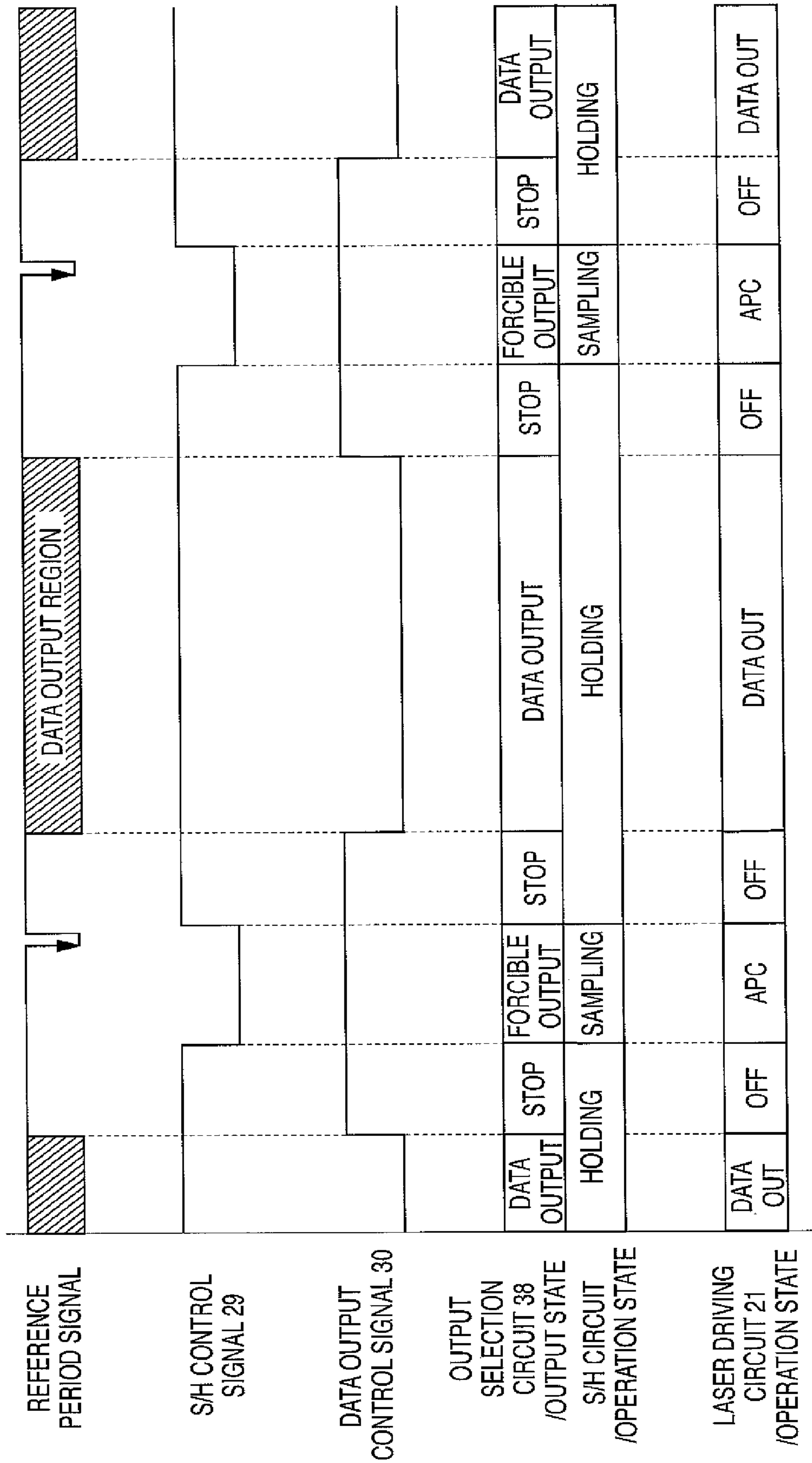


FIG. 1



**FIG. 2**



**FIG. 3**

S/H CONTROL SIGNAL 29	DATA OUTPUT CONTROL SIGNAL 30	S/H CIRCUIT 27	OUTPUT SELECTION CIRCUIT 38	LASER DRIVING CIRCUIT 21 / OPERATION STATE
L	H	SAMPLING	FORCIBLE OUTPUT	LIGHT AMOUNT CONTROL (APC)
H	H	HOLDING	STOP	FORCIBLE LASER OFF
H	L	HOLDING	DATA OUTPUT	DATA OUTPUT
L	L	"0" (INITIAL VALUE)	STOP	RESET STATE

FIG. 4

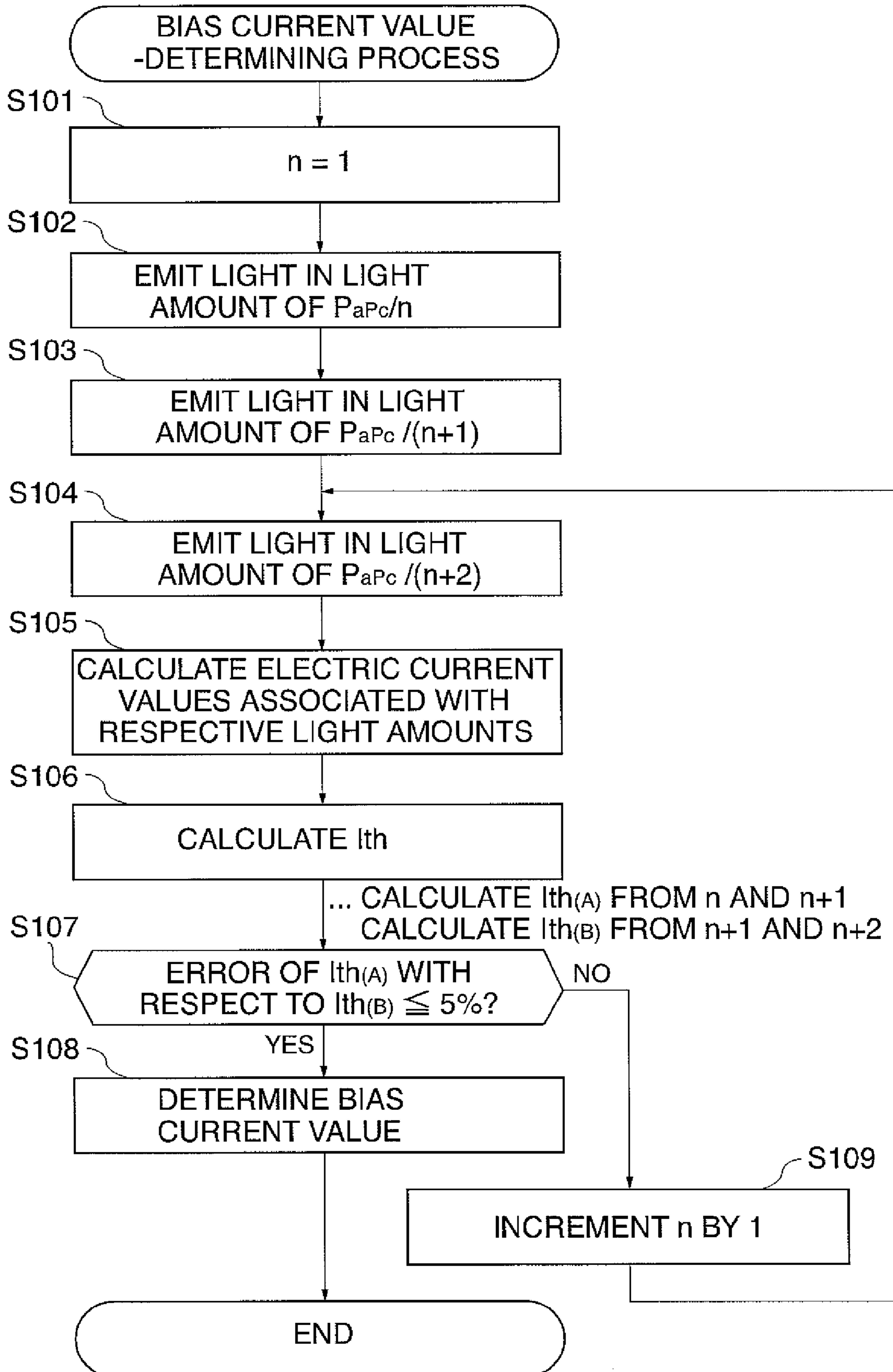


FIG. 5

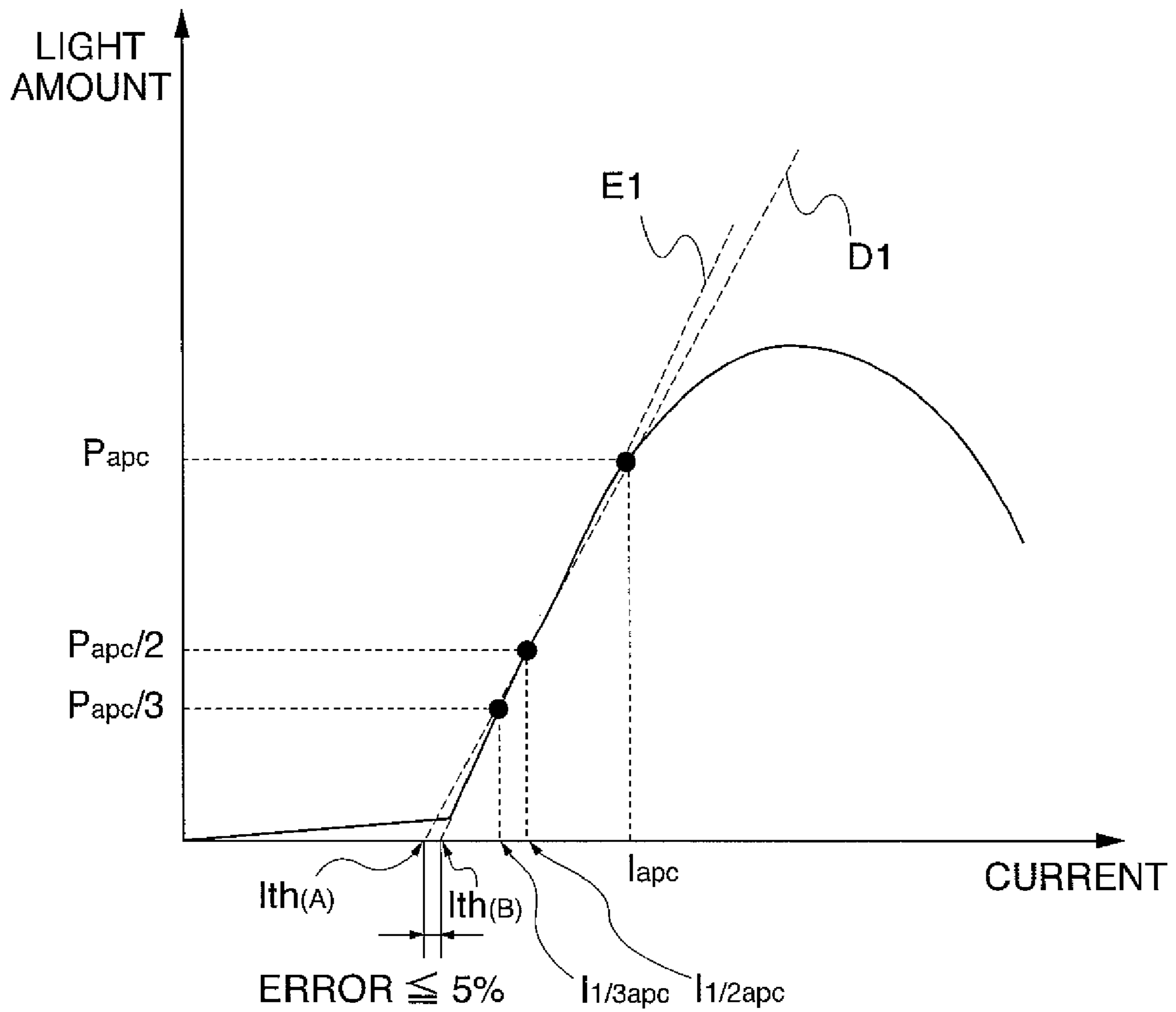
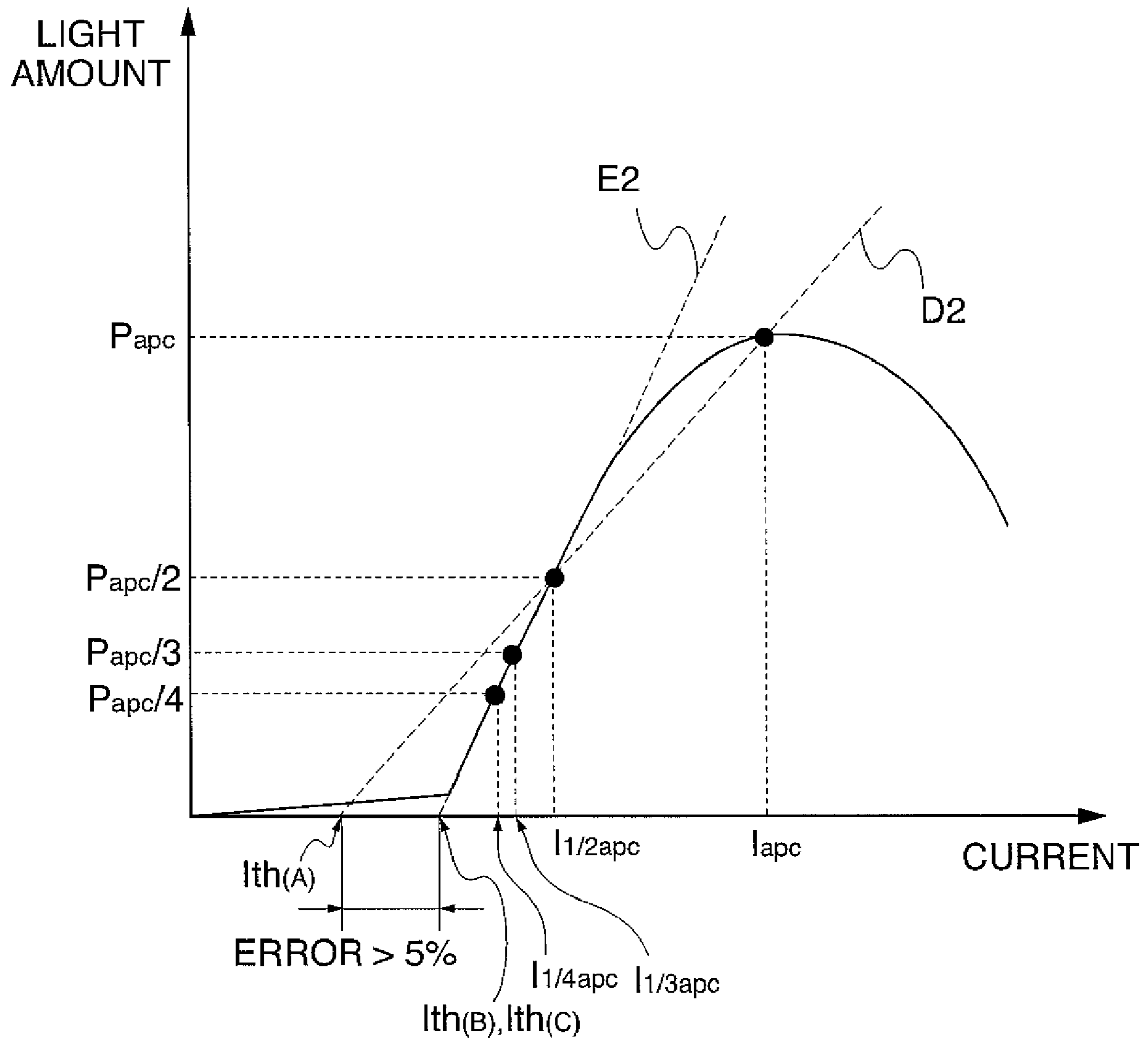


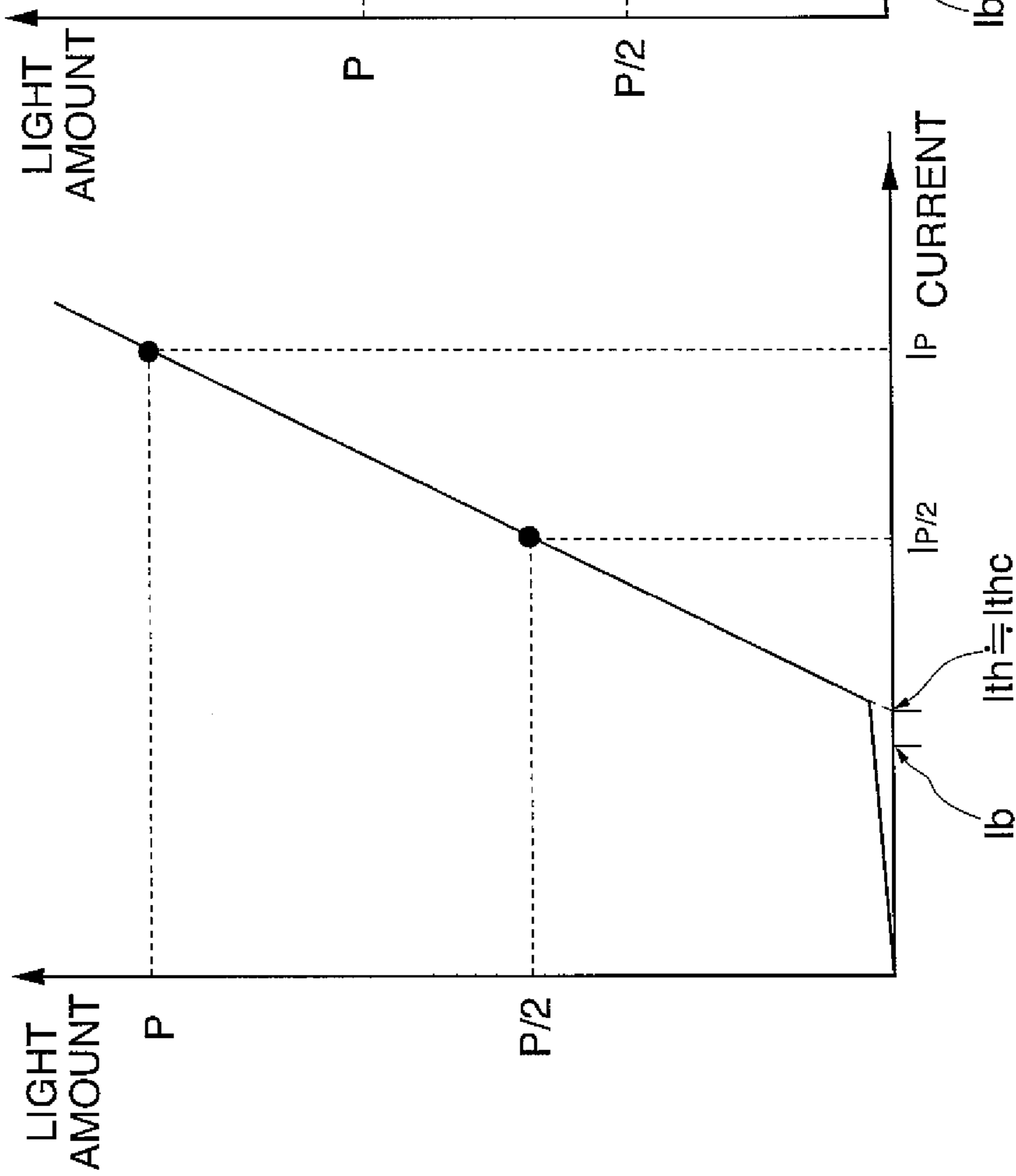
FIG. 6





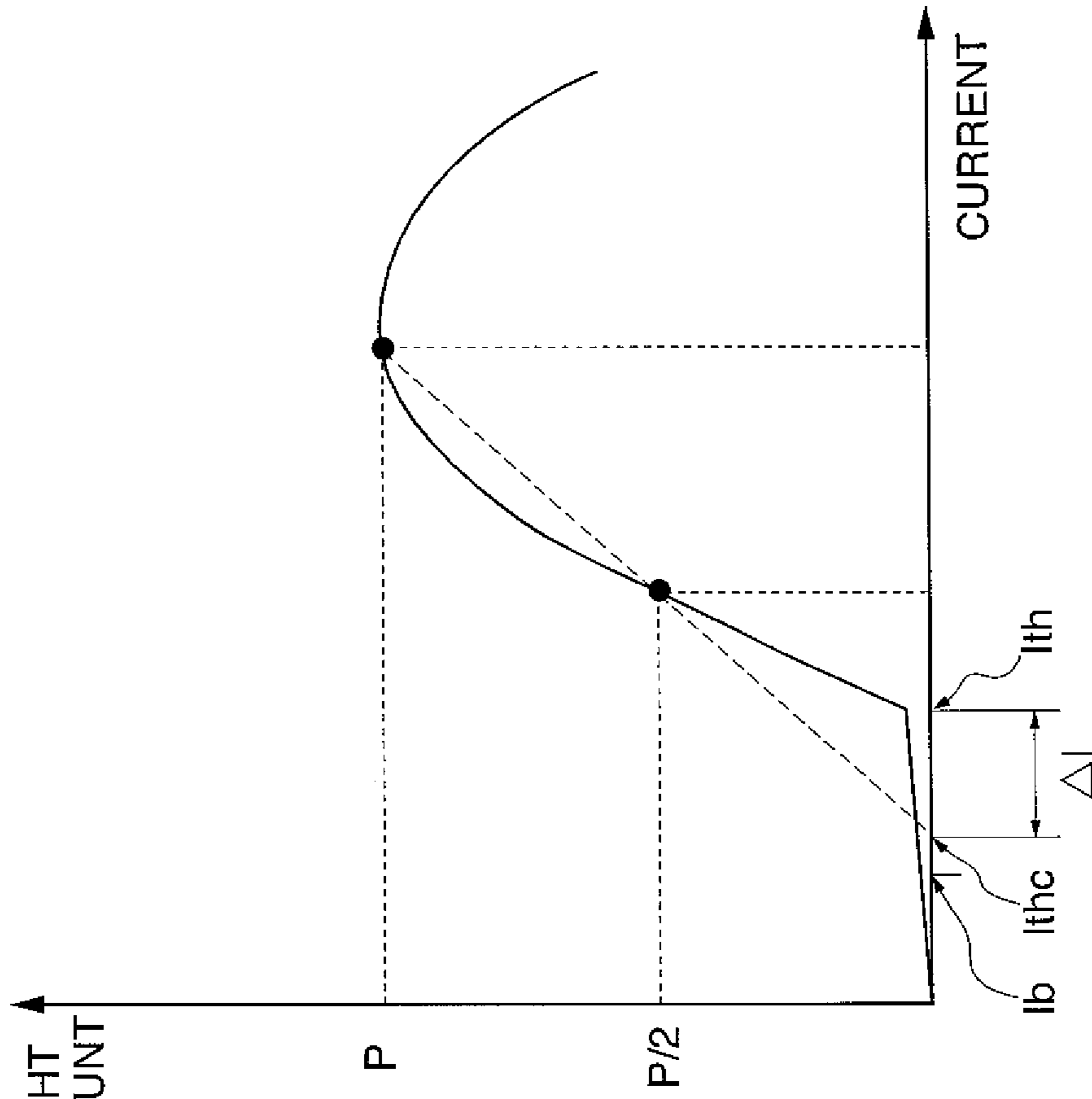
**FIG. 7A**

( $I_{th}$  = ACTUAL LASER THRESHOLD CURRENT VALUE,  
 $I_{thc}$  = CALCULATED LASER THRESHOLD CURRENT VALUE)



**FIG. 7B**

( $I_{th}$  = ACTUAL LASER THRESHOLD CURRENT VALUE,  
 $I_{thc}$  = CALCULATED LASER THRESHOLD CURRENT VALUE)





## LASER DIODE DRIVING DEVICE AND OPTICAL SCANNING DEVICE

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

The present invention relates to a laser diode driving device and an optical scanning device.

#### 2. Description of the Related Art

There has been proposed a technique related to a laser diode driving device, in Japanese Patent Laid-Open Publication No. H11-245444, in which the value of a bias current to be applied to a laser diode is determined based on two amounts of laser emission and current values corresponding to the respective amounts of laser emission.

However, the conventional technique has a problem with a method of calculating the bias current to be applied to the laser diode.

A laser diode, particularly a VCSEL (semiconductor vertical-cavity surface-emitting laser) sometimes has a current-light amount characteristic which assumes an extreme value as shown in FIG. 6. In a case where the current-light amount characteristic assumes an extreme value, when a threshold current value  $I_{thc}$  of the laser diode is calculated based on the two amounts of laser emission and the current values corresponding thereto, the threshold current value  $I_{thc}$  deviates from an actual threshold current value  $I_{th}$  by  $\Delta I$  as shown in FIGS. 7A and 7B.

A bias current value  $I_b$  is calculated based on the obtained threshold current value  $I_{thc}$ , and hence the value  $I_b$  to be set close to the target value  $I_{th}$  deviates therefrom. When the bias current value deviates from the target value, the light emitting characteristics of the laser become unstable. For example, when the laser is used in an optical communication apparatus, troubles occur in data transmission. Further, when the laser is used in an image forming apparatus, variation occurs in output of highlight-side density depending on the environment.

### SUMMARY OF THE INVENTION

The present invention provides a laser diode driving device and an optical scanning device which are capable of obtaining a stable pulse emission state even when variation in the current-light amount characteristic of a laser diode thereof is caused by environmental changes.

In a first aspect of the present invention, there is provided a laser diode driving device comprising a light amount-detecting unit adapted to detect an amount of light emitted from a laser diode, a light amount-determining unit adapted to determine an amount of light to be emitted from the laser diode, a light amount control unit adapted to control the laser diode to emit light in the light amount determined by the light amount-determining unit, and a bias current value-determining unit adapted to determine a bias current value based on results of light emission performed by the laser diode in three or more light amounts determined by the light amount-determining unit.

In a second aspect of the present invention, there is provided an optical scanning device comprising a light amount-detecting unit adapted to detect an amount of light emitted from a laser diode, a light amount-determining unit adapted to determine an amount of light to be emitted from the laser diode, a light amount control unit adapted to control the laser diode to emit light in the light amount determined by the light amount-determining unit, and a bias current value-determining unit adapted to determine a bias current value based on

results of light emission performed by the laser diode in three or more light amounts determined by the light amount-determining unit.

The laser diode driving device and the optical scanning device are provided with the light amount-detecting unit adapted to detect the amount of light emitted from a laser diode, the light amount-determining unit adapted to determine the amount of light to be emitted from the laser diode, and the light amount control unit adapted to control the laser diode to emit light in the light amount determined by the light amount-determining unit. Further, the devices have the bias current value-determining unit adapted to determine a bias current value based on results of light emission performed by the laser diode in three or more light amounts determined by the light amount-determining unit.

With this configuration, a stable pulse emission state can be obtained even when variation in the current-light amount characteristic of the laser diode is caused by environmental changes.

The features and advantages of the invention will become more apparent from the following detailed description taken in conjunction with the accompanying drawings.

### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of a laser diode driving device according to an embodiment of the present invention.

FIG. 2 is a timing diagram of a control sequence executed by the laser diode driving device in FIG. 1.

FIG. 3 is a table of laser control modes performed by the laser diode driving device in FIG. 1.

FIG. 4 is a flowchart of a bias current-determining process executed by the laser diode driving device in FIG. 1 so as to determine a bias current to be applied to an LD.

FIG. 5 is a diagram showing a characteristic of a semiconductor laser (laser diode) appearing in FIG. 1 (No. 1).

FIG. 6 is a diagram showing a characteristic of the semiconductor laser (laser diode) appearing in FIG. 1 (No. 2).

FIGS. 7A and 7B are diagrams showing characteristics of a conventional laser diode.

### DETAILED DESCRIPTION OF THE EMBODIMENTS

The present invention will now be described in detail with reference to the drawings showing an embodiment thereof.

FIG. 1 is a block diagram of a laser diode driving device according to the embodiment of the present invention.

Connected to the laser diode driving device **11** are a semiconductor laser (laser diode: hereinafter abbreviated as "the LD") **12**, a photodiode (hereinafter abbreviated as "the PD") **13**, and an image controller **14**.

The laser diode driving device **11** is comprised of a laser controller **20** and a laser driving circuit **21**. A drive current to be supplied to the LD **12** is controlled by the laser driving circuit **21**, whereby the LD **12** is caused to constantly emit a predetermined amount of light.

The laser controller **20** functions as a light amount-determining unit for determining the amount of light to be emitted from the LD **12**. The laser controller **20** also functions as a light amount control unit for controlling the LD **12** so as to cause the same to emit an amount of light determined by the light amount-determining unit.

The PD **13** as a light amount-detecting unit for monitoring a laser beam output from the LD **12** (i.e. detecting the amount of light from the laser diode) outputs an electric current corresponding to the light amount of the monitored laser beam. A



light amount-adjusting variable resistor **23** performs adjustment such that the LD **12** emits a predetermined amount of light.

The electric current (PD current) **22** output from the PD **13** according to the light amount of the monitored laser beam is converted into voltage by the light amount-adjusting variable resistor **23** and is output as a PD voltage signal **24**. The PD voltage signal **24** is input to a sample/hold circuit **27** together with a light amount-determining signal **26** output from the laser controller **20**.

When a sample/hold (hereinafter abbreviated as S/H) control signal **29** output from the laser controller **20** requests sampling, the sample/hold circuit **27** makes a comparison between the PD voltage signal **24** and the light amount-determining signal **26**.

Then, when the PD voltage signal **24** is lower than the light amount-determining signal **26**, the PD voltage signal **24** is charged in a hold capacitor **51**, whereas when the PD voltage signal **24** is higher than the light amount-determining signal **26**, the PD voltage signal **24** is discharged from the hold capacitor **51**. Thus, a voltage value **28** dependent on the PD current **22** output from the PD **13** is caused to increase or decrease, whereby the LD **12** is controlled to the predetermined amount of light.

When the S/H control signal **29** requests holding, the voltage value **28** determined based on a result obtained depending on the PD current **22** when sampling was requested is held in the hold capacitor **51**.

A current mirror circuit **31** as a current control circuit is comprised of transistors **31a** and **31b**. The mirror ratio of the current mirror circuit **31** is set to e.g. approximately 40. When data output is requested, the voltage value **28** output from the sample/hold circuit **27**, which is dependent on the PD current **22** output from the PD **13**, is input to the positive input terminal of an operational amplifier **52** in response to the S/H control signal **29** input from the laser controller **20**. As a consequence, an electric current output from the emitter of a transistor **53** flows through a resistor **54**.

It should be noted that the value of voltage generated across the resistor **54** is output as an LD current detection signal **56** to the laser controller **20** via an operational amplifier **55**. Since the mirror ratio of the current mirror circuit **31** is set to approximately 40, a laser drive current **32** output from a collector side of the transistor **31a** of the current mirror circuit **31** becomes approximately 40 times larger than the current flowing through the resistor **54**.

A differential receiver (LVDS) **35** having a differential input receives a non-inverted data signal **33** and an inverted data signal **34** each input from the image controller **14**. An output selection circuit **38** outputs a first switching signal **39** or a second switching signal **40** determined by the S/H control signal **29** or a data output control signal **30**.

A current driver **41** has transistors **41a** and **41b** and is configured as a differential amplifier by connecting emitter terminals of the respective transistors **41a** and **41b** to each other. The transistor **41a** switchingly drives the LD **12** based on the first switching signal **39**, using the laser drive current **32**. Similarly, the transistor **41b** switchingly drives a load resistor **42** based on the second switching signal **40**, using the laser drive current **32**.

A bias current-determining section **57** outputs an electric current according to a bias current-setting signal **50** such that the ratio of a value of a bias current supplied to the LD **12** to a laser threshold current value  $I_{th}$  of the LD **12** or the amount of the bias current does not change.

The function of the bias current-determining section **57** as a bias current value-determining unit will be described in more detail.

The bias current-determining section **57** determines a bias current value based on the values of respective electric currents applied to the LD **12** when the LD **12** is caused to emit light in two different amounts.

Further, the bias current-determining section **57** determines a bias current value through comparison between bias current values obtained from the values of the respective electric currents applied to the LD **12** when the LD **12** is caused to emit light in the two different amounts.

Furthermore, the bias current-determining section **57** determines a bias current value based on the values of respective electric currents applied to the LD **12** when the LD **12** is caused to emit light in two amounts except a maximum amount which are selected from a three or more amounts.

Now, various kinds of laser control modes performed by the laser diode driving device **11** in FIG. **1** will be described with reference to FIGS. **2** and **3**.

(1) When the laser diode driving device **11** is in a laser control mode in which the laser driving circuit **21** is set to perform automatic light amount control ("APC (Automatic Power Control)), and the sample/hold circuit **27** is in a sampling state, the output selection circuit **38** forcibly outputs ON data to cause the LD **12** to emit light, irrespective of a receiver non-inverting output signal **36** and a receiver inverting output signal **37** output from the LVDS **35**, to thereby perform, using a signal corresponding to a difference between the PD voltage signal **24** and the light amount-determining signal **26**, control for adjusting the amount of light emitted from the LD **12** to a predetermined light amount as follows:

In the case of PD voltage signal **24**>light amount-determining signal **26**: It is determined that the light emission amount of the LD **12** is larger than the predetermined light amount, and the hold capacitor **51** is discharged. As a consequence, the voltage value **28** dependent on the PD current **22** output from the PD **13** is lowered to reduce the laser drive current **32**, whereby the light emission amount of the LD **12** is reduced.

In the case of PD voltage signal **24**<light amount-determining signal **26**: It is determined that the light emission amount of the LD **12** is smaller than the predetermined light amount, and the hold capacitor **51** is charged. As a consequence, the voltage value **28** dependent on the PD current **22** output from the PD **13** is raised to increase the laser drive current **32**, whereby the light emission amount of the LD **12** is increased.

In the case of PD voltage signal **24**=light amount-determining signal **26**: It is determined that the light emission amount of the LD **12** is equal to the predetermined light amount, and the hold capacitor **51** is neither charged nor discharged. As a consequence, both the voltage value **28** dependent on the PD current **22** output from the PD **13** and the laser drive current **32** are neither increased nor reduced.

(2) When the laser diode driving device **11** is in a laser control mode in which the laser driving circuit **21** is set to forcibly turn off the laser (OFF), and the sample/hold circuit **27** is in a holding state, the voltage value **28** set by the sample/hold circuit **27** depending on the PD current **22** output from the PD **13** is held, and the output selection circuit **38** forcibly outputs OFF data to turn off the LD **12** to stop light emission, irrespective of the receiver non-inverting output signal **36** and the receiver inverting output signal **37**.

(3) When the laser diode driving device **11** is in a laser control mode in which the laser driving circuit **21** is set to output data (DATA OUTPUT), and the sample/hold circuit **27**



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is in the holding state, the output selection circuit 38 outputs a signal corresponding to the receiver non-inverting output signal 36 or the receiver inverting output signal 37, using voltage value 28 set by the sample/hold circuit 27 depending on the PD current 22 output from the PD 13, whereby an electric current is caused to flow through the LD 12 or the resistor 42.

(4) When the laser diode driving device 11 is reset, the laser driving circuit 21 is brought into a reset state, and the electric current set in the sample/hold circuit 27 is initialized, and at the same time, the output selection circuit 38 forcibly outputs OFF data to turn off the LD 12.

FIG. 4 is a flowchart of a bias current-determining process executed by the laser diode driving device in FIG. 1 so as to determine a bias current to be applied to the LD.

First, a description will be given of steps S101 to S105.

I. The above-mentioned automatic light amount control is executed so as to adjust the light emission amount of the LD 12 to a light amount  $P_{aPc}$  for data light emission.

First in the step S101,  $n$  is set to 1, and then in a step S102, APC light emission is executed with the light amount  $P_{aPc}$ . Voltage having a value corresponding to the value of electric current applied to the LD 12 in this state is output between the resistor 54 and ground GND. At this time, the light amount-determining signal 26 is set to  $V_{ref-aPc}$ . When the resistance value of the resistor 54 is represented by  $R_{54}$ , and an electric current flowing through the LD 12 by  $I_{aPc}$ , a voltage  $V_{54aPc}$  generated between the resistor 54 and the GND can be calculated by the following equation:

$$V_{54aPc} = I_{aPc} \times R_{54} / 40 \quad A$$

The voltage value of  $V_{54aPc}$  is output to the laser controller 20 via the operational amplifier 55. In the step S105, the electric current  $I_{aPc}$  is calculated from the equation A, and the calculated current value is stored in a memory of the laser controller 20. In this connection, the current value is calculated by the following equation:

$$I_{aPc} = 40 \times V_{54aPc} / R_{54}$$

II. APC is executed with a light amount  $P_{aPc}/2$  which is half the light amount set in the stage I.

When the light amount-determining signal 26 is set to  $V_{ref-aPc}/2$  in the step S103 so as to cause the LD 12 to emit light in the light amount  $P_{aPc}/2$  which is half the light amount set in the stage I, the PD voltage signal 24 becomes higher than the light amount-determining signal 26, whereby the electric current flowing to the LD 12 is reduced as described in the case (1). A voltage  $V_{541/2aPc}$  generated between the resistor 54 and the GND at this time can be calculated by the following equation:

$$V_{541/2aPc} = I_{1/2aPc} \times R_{54} / 40 \quad B$$

The voltage value of  $V_{541/2aPc}$  is output to the laser controller 20 via the operational amplifier 55. In the step S105, the electric current  $I_{1/2aPc}$  is calculated from the equation B, and the calculated current value is stored in the memory of the laser controller 20. Incidentally, the current value is calculated as follows:

$$I_{1/2aPc} = 40 \times V_{541/2aPc} / R_{54}$$

III. APC is executed with a light amount  $P_{aPc}/3$  which is one third of the light amount set in the stage I.

When the light amount-determining signal 26 is set to  $V_{ref-aPc}/3$  in the step S104 so as to cause the LD 12 to emit light in the light amount  $P_{aPc}/3$  which is one third of the light amount set in the case I, the PD voltage signal 24 becomes higher than the light amount-determining signal 26, whereby

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the electric current flowing to the LD 12 is reduced as described in the case (1). A voltage  $V_{541/3aPc}$  generated between the resistor 54 and the ground GND in association with current flowing through the LD 12 at the time can be calculated by the following equation:

$$V_{541/3aPc} = I_{1/3aPc} \times R_{54} / 40 \quad C$$

The voltage value of the voltage  $V_{541/3aPc}$  is output to the laser controller 20 via the operational amplifier 55. In the step S105, the electric current  $I_{1/3aPc}$  is calculated from the equation C, and the calculated current value is stored in the memory of the laser controller 20. In this connection, the current value is calculated by the following equation:

$$I_{1/3aPc} = 40 \times V_{541/3aPc} / R_{54}$$

Next, a description will be given of a step S106 for calculating the laser threshold current value  $I_{th}$  from the light amounts and the current values.

IV. The laser threshold current value  $I_{th}$  is calculated from the relationship between the light amounts  $P$  and the electric currents  $I$  associated with the LD 12, which are calculated in the stages I, II, and III.

A laser threshold current value  $I_{th}$  (A) is tentatively calculated from the relationship between the light amounts  $P_{aPc}$ ,  $P_{aPc}/2$ , and  $P_{aPc}/3$  and the electric currents  $I_{aPc}$ ,  $I_{1/2aPc}$ , and  $I_{1/3aPc}$  corresponding to the respective light amounts. Since the light amount  $P$  and the electric current  $I$  are calculated as  $P_{aPc}$  and  $I_{aPc}$  in the stage I and as  $P_{aPc}/2$ , and  $I_{1/2aPc}$  in the stage II, the laser threshold current value  $I_{th}$  (A) can be calculated by the following equation:

$$I_{th}(A) = I_{aPc} - P_{aPc} \times (I_{aPc} - I_{1/2aPc}) / (P_{aPc} - P_{aPc}/2) \quad D$$

Then, a laser threshold current value  $I_{th}$  (B) is tentatively calculated from the relationship between the light amounts  $P$  and the electric currents  $I$  in the stages II and III. Since the light amount  $P$  and the electric current  $I$  are calculated as  $P_{aPc}/2$  and  $I_{1/2aPc}$  in the stage II, and as  $P_{aPc}/3$  and  $I_{1/3aPc}$  in the stage III, the laser threshold current value  $I_{th}$  (B) can be calculated by the following equation:

$$I_{th}(B) = I_{1/2aPc} - P_{aPc}/2 \times (I_{1/2aPc} - I_{1/3aPc}) / (P_{aPc}/2 - P_{aPc}/3) \quad E$$

Finally, a description will be given of steps S107 to S109.

V. The two laser threshold current values calculated in the stage IV are compared with each other to thereby determine a bias current to be applied to the LD 12.

If it is determined in the step S107, based on the result of comparison between the laser threshold current values  $I_{th}$  (A) and  $I_{th}$  (B), that an error of  $I_{th}$  (A) with respect to  $I_{th}$  (B) is e.g. within 5%, it is judged that the relationship between the light amount and the electric current corresponds to that between linear expressions denoted by E1 and D1 in FIG. 5 (which means that the relationship between the light amount of which values are  $P_{aPc}$ ,  $P_{aPc}/2$ , and  $P_{aPc}/3$  and the current of which respective associated values are  $I_{aPc}$ ,  $I_{1/2aPc}$ , and  $I_{1/3aPc}$  can be expressed by a single linear expression). In this case, it can be said that the calculated laser threshold current value  $I_{th}$  and the actual laser threshold current value  $I_{th}$  of the LD 12 are approximately identical in characteristic, and therefore in the step S108, the bias current value is determined using the laser threshold current value  $I_{th}$  (A).

Now, the reason for determining the bias current value using the laser threshold current value  $I_{th}$  (A) will be explained. The voltage  $V_{54}$  generated between the resistor 54 and the GND is used as a value for use in calculating the laser threshold current value  $I_{th}$ , but when the light amount of the



LD 12 is small, due to a low value of the voltage  $V_{54}$ , an error increases in the calculating the laser threshold current value  $I_{th}$  with high accuracy.

Another reason is that when the LD 12 is a VCSEL, the rated amount per se of light that can be emitted is small, and hence not only further reduction of the value of the voltage  $V_{54}$ , but also reduction of the output of the PD 13 occur, which causes an increase in error in the APC.

The bias current  $I_b$  is calculated in the step S108, provided that the bias current value is set to 90% of the laser threshold current value  $I_{th}$  (A), by the following equation:

$$I_b = 0.9 \times I_{th}(A)$$

On the other hand, if it is determined in the step S107, based on the result of comparison between the laser threshold current values  $I_{th}$  (A) and  $I_{th}$  (B), that the error of  $I_{th}$  (A) with respect to  $I_{th}$  (B) is more than 5%, it is judged that the relationship between the light amount and the electric current corresponds to that between linear expressions denoted by E2 and D2 in FIG. 6 ((which means that the relationship between the light amount of which values are  $P_{aPc}$ ,  $P_{aPc}/2$ , and  $P_{aPc}/3$  and the current of which respective associated values are  $I_{aPc}$ ,  $I_{1/2aPc}$ , and  $I_{1/3aPc}$  cannot be expressed by a single linear expression). In this case, it can be said that the calculated laser threshold current value  $I_{th}$  and the actual laser threshold current value  $I_{th}$  of the LD 12 are largely different in characteristic.

Therefore, in the step S109,  $n$  is incremented by 1 so as to reduce the light amount to a lower level than the light amount  $P_{aPc}/3$  in which light was emitted in the step S104, and then in the step S104, APC is executed with a light amount  $P_{aPc}/4$  which is one fourth of the light amount  $P_{aPc}$ . Then, in the step S106, a laser threshold current value  $I_{th}$  (C) is calculated from the light amounts  $P_{aPc}/3$  and  $P_{aPc}/4$  and the currents  $I_{1/3aPc}$  and  $I_{1/4aPc}$  corresponding to the respective light amounts. Further, in the step S107, the laser threshold current values  $I_{th}$  (B) and  $I_{th}$  (C) are compared in the same manner as described above, to thereby determine whether or not the error between the two values falls within 5%.

This step is repeatedly carried out until the error between the two values falls within 5%. By doing this, it is possible to set the bias current accurately even when the laser diode has a non-linear characteristic having a maximum output light amount on its non-linear portion as shown in FIG. 6.

It should be noted that APC is always executed with the light amount  $P_{aPc}$  during a time period over which the LD 12 performs data output, e.g. in sampling timing in FIG. 2 by way of example. Further, the steps S103 et seq. for determining the bias current value  $I_b$  may be carried out during a time period over which data output is not performed as in FIG. 2. In such a case, when  $n$  is set to 1 and it is determined in the step S107 that the error is more than 5%, and when the sequence for determining the bias current value  $I_b$  is to be operated again, the operation may be started by setting  $n$  to 2. Although in the present embodiment, control is performed for a single laser diode, it is possible to control a plurality of laser diodes.

As described heretofore, by calculating a bias current value from electric current values corresponding, respectively, to three or more kinds of light amounts of a laser diode, it is possible to set the bias current value  $I_b$  close to the threshold current value  $I_{th}$  of the laser diode even when the light amount-electric current characteristic is like the one shown in FIG. 6.

Therefore, trouble in data transfer in an optical communication apparatus or degradation of image quality in an image forming apparatus can be suppressed. Further, since the bias current value can be set close to the threshold current value  $I_{th}$

even when the light amount-electric current characteristic has no linear region, it is possible to perform precise light amount control e.g. even for a VCSEL (semiconductor vertical-cavity surface-emitting laser) having one or more light emitting points.

While the present invention has been described with reference to an exemplary embodiment, it is to be understood that the invention is not limited to the disclosed exemplary embodiment. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all modifications, equivalent structures and functions

This application claims priority from Japanese Patent Application No. 2007-179915 filed Jul. 9, 2007, which is hereby incorporated by reference herein in its entirety.

What is claimed is:

1. A laser diode driving device comprising:

a light amount-detecting unit adapted to detect an amount of light emitted from a laser diode;

a light amount-determining unit adapted to determine an amount of light to be emitted from the laser diode;

a light amount control unit adapted to control the laser diode to emit light in the light amount determined by said light amount-determining unit; and

a bias current value-determining unit adapted to determine a bias current value based on results of light emission performed by the laser diode in three or more light amounts determined by said light amount-determining unit,

wherein said bias current value-determining unit determines the bias current value through comparison between (a) a first bias current value obtained from a first line calculated through two points corresponding to electric current values associated with two of the three or more light amounts, and (b) a second bias current value obtained from a second line calculated through two points corresponding to electric current values associated with two of the three or more light amounts, and

wherein a point of the two points associated with the first line is different than a point of the two points associated with the second line.

2. A laser diode driving device as claimed in claim 1, wherein said bias current value-determining unit determines the bias current value based on electric current values of respective electric currents applied to the laser diode when the laser diode is caused to emit light in two different light amounts.

3. A laser diode driving device as claimed in claim 1, wherein said bias current value-determining unit determines the bias current value based on electric current values of respective electric currents applied to the laser diode when the laser diode is caused to emit light in two light amounts except a maximum light amount which are selected from a three or more light amounts.

4. A laser diode driving device as claimed in claim 1, wherein the laser diode is a semiconductor vertical-cavity surface-emitting laser.

5. A laser diode driving device as claimed in claim 1, wherein the laser diode is a semiconductor vertical-cavity surface-emitting laser having one or more light emitting points.

6. An optical scanning device comprising:

a light amount-detecting unit adapted to detect an amount of light emitted from a laser diode;

a light amount-determining unit adapted to determine an amount of light to be emitted from the laser diode;



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a light amount control unit adapted to control the laser diode to emit light in the light amount determined by said light amount-determining unit; and

a bias current value-determining unit adapted to determine a bias current value based on results of light emission performed by the laser diode in three or more light amounts determined by said light amount-determining unit,

wherein said bias current value-determining unit determines the bias current value through comparison between (a) a first bias current value obtained from a first line calculated through two points corresponding to electric current values associated with two of the three or more light amounts, and (b) a second bias current value obtained from a second line calculated through two points corresponding to electric current values associated with two of the three or more light amounts, and

wherein a point of the two points associated with the first line is different than a point of the two points associated with the second line.

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7. An optical scanning device as claimed in claim 6, wherein said bias current value-determining unit determines the bias current value based on electric current values of respective electric currents applied to the laser diode when the laser diode is caused to emit light in two different light amounts.

8. An optical scanning device as claimed in claim 6, wherein said bias current value-determining unit determines the bias current value based on electric current values of respective electric currents applied to the laser diode when the laser diode is caused to emit light in two light amounts except a maximum light amount which are selected from a three or more light amounts.

9. An optical scanning device as claimed in claim 6, wherein the laser diode is a semiconductor vertical-cavity surface-emitting laser.

10. An optical scanning device as claimed in claim 6, wherein the laser diode is a semiconductor vertical-cavity surface-emitting laser having one or more light emitting points.

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